

# **THE CRUSHED STONE JOURNAL**

*Official Publication*  
**The National Crushed Stone Association**

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**DECEMBER, 1927**

**National Crushed Stone Association  
Eleventh Annual Convention  
West Baden, Indiana  
January 16, 17, 18 and 19, 1928**

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**Railroads Authorize Reduced Fare**

***Important—Read Carefully***

1. Reduced fare to West Baden has been authorized under the Round Trip Identification Certificate Plan.
2. Upon presentation of certificate to ticket agent, delegate is entitled to purchase a round trip ticket to West Baden for fare and one-half times the regular one way fare.
3. Certificates *will not* be available at offices of ticket agents, as has been the case in the past and can only be procured from the Secretary's Office in Washington.
4. Certificates are being mailed to all contemplating attendance at the Convention.

***Have You Received Your Certificate?***

If not, you should *immediately* communicate with J. R. Boyd, Secretary, National Crushed Stone Association, 651 Earle Building, Washington, D. C., requesting that one be sent to you.

5. Please help us to pass this information along as it would be regrettable if some of those attending the Convention were denied the privilege of obtaining reduced fare to West Baden because they have failed to obtain a certificate.







# The CRUSHED STONE JOURNAL

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WASHINGTON, D. C.

December, 1927

## President Graves Issues Last Call for West Baden Convention

*To Crushed Stone Producers of the United States  
and Canada.*

Gentlemen:

The interest of the crushed stone industry is centered upon the Eleventh Annual Convention of the Association at West Baden, Indiana, January 16-19th. The several trade journals have each generously devoted a page in each of their issues for some little time to this event and much has been written concerning it in the columns of our own Journal. Therefore, it is at the risk of repetition that I am taking this last opportunity of presenting to you some of the interesting features concerning the West Baden Springs Hotel and the convention itself.

The Hotel is large, comfortable and spacious and the manager, Mr. Hall, is an ideal host who proposes to do his utmost for us individually and collectively to insure our enjoyment and comfort. As you may know by personal experience or from observing various photographs, the hotel is circular and some seven stories in height. About half of the rooms are outside and the remainder open into the circular corridor on the one side and the large central space known as the atrium on the other. Not all of the rooms have baths, though all are provided with toilet facilities. On the seventh floor are located baths of various kinds, enjoyable entirely aside from their curative benefits. These baths are regarded highly by all the guests of the hotel and it is for that reason that individual bathrooms are not provided for all of the guest rooms. The shower bath facilities are available to all attending the convention without charge, while a very moderate fee is charged for the mineral baths and masseur. There is an air of charm and comfort pervading the hotel to an unusual extent which will readily lend itself to the good-fellowship and camaraderie which characterizes our gatherings.

The speakers have been selected with unusual care and discrimination and we are both fortunate and

honored in having so many distinguished engineers, railroad and highway executives, lawyers and business men to address us. It will be observed from the tentative program appearing elsewhere in this issue that ample time is left for general discussion after each address, thus developing ramifications of the thoughts expressed by the speakers.

The afternoon group meetings for operating executives, superintendents and manufacturers, for salesmen, the National Agstone Association and the conference on accident prevention will be particularly instructive and enjoyable this year. Those presiding over these meetings have devoted a considerable amount of time and energy in the preparation of the programs, the prepared addresses merely serving to present various subjects for general discussion.

The exposition of manufacturers' equipment will be held in the large circular central room, the atrium, and will unquestionably be larger and more complete than ever before. Our associate members have recognized the fact that the central location of West Baden, it being but thirty-two miles from the center of population, will tend to substantially increase the attendance and they are also gratified with the location of the exposition. It is for such reasons that more manufacturers are exhibiting and to a larger extent. The value of the opportunity to inspect quarry equipment and supplies and for executives and superintendents to discuss with manufacturers' representatives the adaptability of their materials to quarry work is self-evident. There is no doubt whatever that the exposition will be one of the high lights of the convention.

The entertainment has been arranged by an active committee of our members, with Col. R. B. Tyler, of Louisville, Kentucky, as chairman. To those who are acquainted with the ease and facility with which Col. Tyler arranges attractive entertainment features no further word will be required. We had rather hoped that we would be permitted to tell you of

some of the special attractions which are being provided, but the committee wishes to surprise you and I know it will. The provision which has been made for Monday and Tuesday evening to pleasantly while away the time is unique to an unusual and even astonishing degree. Since there are no theatres and cabarets surrounding the hotel, as has been the case in previous years, the committee has realized that delightful entertainment must be provided within the hotel, and this duty it has discharged splendidly. The Indiana producers, as a tangible expression of their appreciation of the convention being held in their State, are generously contributing the entertainment for the smoker and get-together meeting Monday evening and they promise us a series of interesting events.

The ladies of our families are particularly invited to meet with us. Arrangements have been made for their entertainment by Mrs. Grace Evans, of the Monon Crushed Stone Co., as chairman of a subcommittee for that purpose, and those who have the pleasure of knowing Mrs. Evans will realize that what she undertakes is well done and in good taste. We hope to have more of our ladies with us this year than ever before and we believe that they will thoroughly and fully enjoy their visit with us.

**Guests.** It has been the pleasing custom of some of our member companies to invite town, county and state highway officials to accompany them to our conventions and this year will surely prove no exception. The recipient of such an invitation must certainly appreciate the compliment and honor and you may be assured that the convention this year will be so thoroughly enjoyable and instructive as to warrant your extending such invitations as freely as you may desire.

**Reservations** for rooms at the hotel should be made immediately if the matter has not already been attended to. The most desirable rooms will be taken first and though all of the rooms are comfortable, the only sure way to secure the exact reservations you may desire is by requesting them as far in advance as can be arranged.

**Transportation** is being arranged in special cars from various sections of the country because of the convenience and pleasure in traveling with one's neighbors.

**Certificates** have been mailed to all of our members and should be presented when purchasing a round-trip ticket to West Baden, which will entitle the holder to such transportation for fare and one-half, a

plan which materially differs from that which we have followed in past years. We are in this manner assured of fare and a half without the necessity of validating two hundred and fifty or more certificates at the convention. If such a number of transportation certificates as may be required by your company have not reached you, please notify our Secretary to that effect.

The saving assured by reason of the fare and a half arranged with the carriers, together with the low rates offered by the hotel on the American plan, indicates that it will be considerably less expensive to attend this convention than any of our others, thereby enabling the various companies to take more of their men at no greater expense than a lesser number in previous years.

Personally, I am looking forward with sincere pleasure and anticipation to the opportunity that the convention affords of renewing old friendships and establishing new ones. This is one of the intangible values, of deep significance, of our annual gatherings, giving to us, as it does, a greater joy in our occupation.

Sincerely yours,

OTHO M. GRAVES.

## West Baden Springs Hotel Offers Attractive Convention Rates

The West Baden Springs Hotel, convention headquarters for our Eleventh Annual Convention, which will be held at West Baden, Indiana, January 16 to 19, 1928, has quoted unusually attractive rates to delegates for the period of the convention as follows:

### All Rates on American Plan

#### Outside rooms with bath—

Rate with double bed, \$10 per day single; \$18 per day double.

Rate with twin beds, \$20 per day.

#### Outside rooms without bath—

Rate, single, \$8 and \$9 per day.

Rate, double, \$15, \$16 and \$17 per day.

Inside rooms with bath are arranged so that each suite consists of two rooms connected through a bath. Each of these rooms is equipped with double beds. The rate per day is \$8 per person.

#### Inside rooms without bath—

Single, \$7 per day; double, \$14 per day.

It is suggested that those desiring reservations immediately communicate with the West Baden Springs Hotel, direct, stating that reservations are desired in connection with the National Crushed Stone Association Convention.

# Tentative Program West Baden Convention

January 16, 17, 18 and 19, 1928

*The Following Program is Incomplete and Subject to Change*

## Monday, January 16, 1928

### Morning Session

Otho M. Graves, Presiding

- 10:00 Address of Welcome—Hon. Albert J. Wedeking, Member Indiana State Highway Commission and Legislature.
- 10:15 Response for the Association—L. R. Cartwright, Vice President, Midwest Crushed Stone Company, Indianapolis, Ind.
- 10:25 Presidential Address, Otho M. Graves.
- 11:00 Appointment of Convention Committees:  
     Rules and Procedure.      Auditing.  
     Resolutions.              Reception.  
     Nominating.              Publicity.
- 11:15 Report of Directors on Business Conditions in 1927 and the Outlook for 1928.
- 12:45 to 2:00 P. M. Greeting Luncheon. Every one, including active and associate members, as well as guests, is cordially invited to attend.
- Luncheon Address—"Industrial Sovereignty and Common Welfare," William J. Matthews, Attorney-at-Law, Chicago and New York, Counsel for various trade organizations.

## Monday, January 16, 1928

### Afternoon Session

- 2:30 "Bituminous Tops for Old Roads," A. H. Hinkle, Superintendent of Maintenance, State Highway Department, Indianapolis, Ind.
- 2:50 Discussion of preceding address—opened by George E. Martin, Consulting Engineer, The Barrett Company, New York City.
- 3:00 "How a Research Laboratory Will Benefit the Crushed Stone Industry," A. T. Goldbeck, Director, Bureau of Engineering, National Crushed Stone Association.
- 3:30 Discussion of Bureau of Engineering—opened by F. C. McKee, Chairman of Committee on Research, Pittsburgh, Pa.
- 4:00 General Business.
- 4:15 Adjournment.

## Monday Evening, 7:30 P. M.

- 7:30 Opening of Manufacturers' Division Exposition of Quarry Equipment and Machinery.
- 9:30 Smoker and Entertainment contributed by Indiana Producers.

## Tuesday, January 17, 1928

### Morning Session

- 10:00 Report of Committee on Standards—Col. O. P. Chamberlain, Chairman.  
     Subcommittee on Standardization of Drilling Equipment, Fred A. Gill, Chairman.  
     Subcommittee on Standardization of Quarry Tracks and Cars, W. E. Farrell, Chairman.  
     Subcommittee for the Standardization of Commercial Sizes of Crushed Stone, W. R. Sanborn, Chairman.
- 10:25 Report of Committee on Membership, J. R. Boyd, Chairman.
- 10:30 "Broken Stone Cost Keeping Suggestions," Dr. George E. Ladd, Bureau of Public Roads, Washington, D. C.
- 11:00 Discussion of preceding address—opened by J. R. Thoenen, Mining Engineer, Nonmetallic Minerals Station, Bureau of Mines, New Brunswick, N. J.
- 11:15 "Recent Steps in Business Self-government," Gilbert H. Montague, Counsellor at Law, N. Y. City.
- 11:45 Discussion of preceding address—(Not yet determined.)
- 11:55 "Efficient Transportation," H. G. Taylor, Manager, Public Relations Section, Car Service Division, American Railway Association, Wash., D. C.
- 12:25 Discussion of preceding address—opened by John Rice, Chairman, Mineral Aggregates Committee, Atlantic States Shippers Advisory Board, Easton, Pa.
- 12:35 General Convention Business.
- 12:45 Adjournment.

## Tuesday, January 17, 1928

### Luncheons and Afternoon Group Meetings

#### Operating Men, Superintendents and Manufacturers

- A. G. Seitz, Rock-Cut Stone Company, Presiding
- 1:00 Luncheon.
- 1:45 "Truck Operation in Quarries," F. S. Jones, Production Engineer, General Crushed Stone Co., Easton, Pa.
- 2:00 General discussion of preceding address.
- 2:15 "Analysis of Relative Values of Various Vibrating Screens," D. W. Yambert, The France Stone Co., Toledo, Ohio.
- 2:30 Discussion of preceding address.
- 2:45 "Question Box" on Quarry Operations.
- 3:00 Motion Pictures by Hercules Powder Co., covering quarry operations.
- 3:15 Tour of Exposition under direction of Manufacturers.
- 4:15 Automobile trip to French Lick and other points.

**Sales Group**

- H. B. Allen, The General Crushed Stone Company, Presiding
- 1:00 Luncheon.
  - 2:00 "The Ethics of Competition"—(Speaker not yet determined.)
  - 2:10 Discussion of preceding address.
  - 2:20 "The Value of Advertising to an Association"—(Speaker not yet determined.)
  - 2:30 Discussion of preceding address.
  - 2:40 "The Value of Advertising to the Individual Producer," W. Scott Eames, General Manager, The New Haven Trap Rock Company, New Haven, Conn.
  - 2:50 "The Storage of Stone at Service Plants as a Means of Increasing Sales," A. L. Worthen, V-Pres., Connecticut Quarries Co., Inc., New Haven, Conn.
  - 3:00 Discussion of preceding address.
  - 3:10 "The Use of Association Publications in Increasing Sales," J. R. Boyd, Secretary, National Crushed Stone Association, Washington, D. C.
  - 3:20 Discussion of preceding address.
  - 3:30 "The Bureau of Engineering and Sales," A. T. Goldbeck, Director, Bureau of Engineering, National Crushed Stone Association, Washington, D. C.
  - 3:40 Discussion of preceding address.
  - 3:50 General business.
  - 4:00 Adjournment.

**General Luncheon**

Speakers, Guests and All Those Desiring to Attend.

- 1:00 Luncheon.
- General discussion—no formal program.
- 2:15 Adjourn to attend either the meeting for Operating Men, Superintendents and Manufacturers or that of the Sales Group, as may be individually desired.

**Tuesday Evening**

- 8:15 Vaudeville show imported from Chicago.

**Wednesday, January 18, 1928****Morning Session**

- 10:00 "Development of Tennessee's Highway System," C. N. Bass, Commissioner of Highways and Public Works, Tenn.
- 10:30 Discussion of preceding address—opened by H. E. Rodes, Franklin Limestone Company, Nashville, Tenn.
- 10:40 "How a Mineral Aggregate Association Can Cooperate to Assure the Furnishing of Specified Material," H. S. Mattimore, Engineer of Tests and Materials Investigation, Department of Highways, Pa.
- 11:10 Discussion of preceding address—opened by P. J. Freeman, Chief Engineer, Bureau of Tests and Specifications, Department of Public Works, Allegheny County, Pa.
- 11:20 "The Value of Research," Charles M. Upham, Director, Highway Research Board, Consulting Highway Engineer, and Business Director, American Road Builders Association, Washington, D. C.

- 11:50 Discussion of preceding address—opened by C. N. Conner, Chairman, Committee on Low Cost Improved Roads, Highway Research Board, Washington, D. C.
- 12:00 Address—J. V. Neubert, Chief Engineer Maintenance of Way, The New York Central Railroad Company, New York City.
- 12:20 Discussion of preceding address.
- 12:30 Report of Committee on Welfare and Safety, N. S. Greensfelder, Chairman.
- 12:35 General Business.
- 12:45 Adjournment.

**Wednesday, January 18, 1928****Luncheons and Afternoon Group Meetings****Annual Meeting National Agstone Association**

L. E. Poorman, President, Presiding

*(This meeting is open to everyone interested in the production and marketing of agricultural limestone, whether or not a member of this Association.)*

- 1:00 Luncheon.
- 1:45 Address by Leo E. Poorman, President.
- 2:00 Address—E. J. Leenhouts, Gen. Agri. Agt., New York Central Railroad Company, giving his views of the Agstone industry from a railroad standpoint.
- 2:20 Discussion.
- 2:30 Address—Dr. Firman Bear, Director of Soils Department, Ohio State University, Columbus, Ohio.
- 3:00 Address—J. C. King, Sales Manager, Carbon Limestone Company, Youngstown, O.
- 3:30 Committee Reports.
- 3:35 Election of Directors.
- 3:45 Directors Meeting for election of officers.
- 4:00 Adjournment.

**Accident Prevention Conference**

D. C. Souder, Chairman, Quarry Section, National Safety Council, Presiding

- 1:00 Luncheon.
- 1:45 Address—R. P. Blake, Sales Engineer, Independence Bureau, Philadelphia, Pa.
- 2:05 Discussion of preceding address.
- 2:15 Address—W. H. Weitknecht, General Superintendent, Lehigh Portland Cement Company, Mitchell, Indiana.
- 2:35 Discussion of preceding address.
- 2:45 Address—W. W. Adams, Supervising Statistician of Accident Statistics Section, Bureau of Mines, Washington, D. C.
- 3:05 Discussion of preceding address.
- 3:15 General Business.
- 3:30 Motion picture prepared by Institute of Makers of Explosives.
- 4:00 Inspection first-aid car of Bureau of Mines.

**Wednesday Evening, 7:00 P. M.****Banquet**

Toastmaster—(Not yet determined.)

Speakers—Hon. Harold Van Orman, Lieutenant Governor of Indiana.



Hon. A. J. Brosseau, President, Mack Trucks, Inc., and Chairman of the Highways Committee, National Automobile Chamber of Commerce, Inc., New York City.

Hon. Norman Hapgood, Journalist and Ex-Minister to Denmark, New York City.

Presentation of N. C. S. A. Safety Trophy.

### Thursday, January 19, 1928

#### Morning Session

- 10:00 Address—R. T. Giles, Chief Engineer of Concrete Control, Blaw-Knox Co., Pittsburgh, Pa.
- 10:25 Discussion of preceding address.
- 10:30 "Effective Support of Campaigns for Public Improvements," C. D. Franks, Portland Cement Association, Chicago, Ill.
- 10:55 Discussion of preceding address.
- 11:00 "Purchasing and Its Relation to Industrial Progress," M. E. Towner, General Purchasing Agent, Western Maryland Railway Company, Baltimore, Md.
- 11:25 Discussion of preceding address.
- 11:30 "Crushed Stone Industry—Its Value to Transportation," H. O. Hartzell, Executive Assistant to Vice President, Traffic and Commercial Developments, Baltimore & Ohio Railroad, Baltimore, Md.
- 11:55 Discussion of preceding address.
- 12:00 Reports of Convention Committees in order stated.  
       Rules and Procedure.       Resolutions.  
       Auditing.               Nominating.
- 12:30 Installation of President.
- 12:45 Adjournment.

### Thursday, January 19, 1928

#### Afternoon

- 1:00 Farewell luncheon for everyone.
- 2:00 Meeting of Board of Directors and Officers.
- 2:00 Meeting of Manufacturers' Division.

### For The Ladies

#### January 16, 17, 18 and 19

Arrangements have been made to provide special entertainment features for the ladies attending the Convention as follows:

#### Monday Afternoon

Tea, Auction Bridge and Five Hundred at the West Baden Springs Hotel.

#### Monday Evening

Reception. Entertainment features the same as those provided for the men's smoker.

#### Tuesday Afternoon

Automobile trip, visiting French Lick Country Club, Wyandotte Cave, French Lick Hotel, and winter quarters of John Robinson's Circus.

#### Tuesday Evening

Convention theatre party—West Baden Springs Hotel.

#### Wednesday Afternoon

Guests of Hoosier Club.

#### Wednesday Evening

Convention Banquet.

## The 1928 National Safety Competition

Every eligible member of the National Crushed Stone Association should enter the 1928 National Safety Competition. By entering this competition you acknowledge your desire to help promote safety throughout the crushed stone industry; by not entering you fail to give this movement the very earnest support which it most assuredly deserves.

President Graves has appointed a Committee on Welfare and Safety which is under the able chairmanship of Mr. N. S. Greensfelder. This committee immediately after its appointment actively interested itself in this vital and humanitarian work and has really accomplished excellent results, about which detailed information will be forthcoming at the West Baden Convention. This committee, however, no matter how energetic and conscientious its personnel may be, cannot successfully carry on its work without the wholehearted support of our membership.

Judging from the number who entered the 1927 competition, our membership has not responded to the safety movement with the sympathetic and helpful assistance which we most earnestly believe it deserves. President Graves in his paper, "Values of Accident Prevention," presented before the Quarry Section of the National Safety Council at the Sixteenth Annual Safety Congress held in Chicago in September, developed the startling fact that only 27% of our membership was enrolled in the 1927 National Safety Competition. Why is our representation so low? Is it because, as an industry we are not interested in the safety movement or is it perhaps due to a misapprehension on the part of our members that a large amount of red tape and clerical effort is involved.

Entry in the competition only involves the reporting of all accidents to the U. S. Bureau of Mines, this information being held by them as strictly confidential. A great many of our members are required by state law to make such reports to the state insurance commissioners and carbon copies of these reports are entirely acceptable to the Bureau of Mines. It is recognized, of course, that many of our members not entered in this Safety Competition are doing excellent work in the field of safety promotion. Entry in the competition does, however, have the outstanding advantage of making it possible for one central agency (the Bureau of Mines), to collect and tabulate the safety statistics of the industry and later analyze this data for our individual and collective benefit.

(Continued on page 19)

# Summary of Report on Investigation of Low Cost Improved Roads<sup>1</sup>

By C. N. CONNER

*Highway Research Board, Washington, D. C.*

## Introduction

The investigation was conducted more in the nature of a survey of the low-cost road situation than as a detailed and scrutinizing research. This procedure appeared advisable on account of the present need of a large mileage of low-cost roads.

The subject must receive study and investigation if highway service is to keep pace with motor vehicle registration and the increasing radius of travel by motorists, for it has been truly said that we pay for roads whether we have them or not. The sum we pay for not having roads has never been estimated nor can all the benefits be stated in dollars and cents.

The public at large is interested only in improved road service, while the road builder is concerned with furnishing this service at a low cost for construction and maintenance.

The selection of type for these roads may be affected by character and intensity of traffic, interest on investment, cost of replacement, maintenance cost and that somewhat intangible item, cost of vehicle operation.

Calculations based on all of these items has indicated to some persons the selection of a high type surfacing.

However, in many of the West, Middle West and Southern States advantage cannot be taken of the absolute and theoretical economics of the situation if transitory or even temporary service is to be given.

These sections of the country represent a tremendous area, they contain a small population per unit of area and they need a large mileage of serviceable roads.

Some of these states have no treated surfaces and less than 10 miles of pavement, whereas some of the North Eastern States have no untreated surfaces and several thousand miles of pavement in their state highway systems.

Within a few years many have constructed and are maintaining thousands of miles of low-cost roads. Many of these roads furnish continuous service between objectives. Over them the public is traveling in safety and comfort, and at high rates of speed.

This has been made possible by extensive use of local materials and intelligent maintenance.

The successful low-cost surface is a light-traffic road, carrying less than 1500 vehicles per day as a maximum with an average of 600 or less. This may be mixed traffic with a fair percentage of light trucks and an occasional heavy truck.

Low-cost roads of this type will adequately meet the needs of a large area of the country for many years to come, provided intelligent maintenance methods are perpetuated.

In order to determine which types of surfacing and what points of interest on these would be useful to road builders, a canvass was made which showed the points of interest to be:

1. First Cost.
2. Maintenance Cost.
3. Traffic and Service.

Other points included conditions of climate, salvage, soil and subgrade, construction and maintenance methods, typical cross section and topography.

Preference for types to be investigated was affected somewhat by the local conditions surrounding the persons questioned, but the majority favored the following order of importance:

1. Bituminous surface treatments of gravel, stone, slag and miscellaneous materials.
2. Bituminous macadam and various types of bituminous concrete.
3. Untreated surfaces of traffic bound stone or gravel, water bound macadam, earth and sand clay.
4. Non-bituminous surface treatments of gravel, earth and sand clay.

It was felt that all of these types and the factors affecting them should be considered in a survey of this character, but it was early recognized during the investigation that nearly every type and each of the factors affecting them could be made the subject of a separate investigation.

This survey has therefore been confined to those types which are considered as serviceable investments by those responsible for their existence.

<sup>1</sup>Presented at the Seventh Annual Meeting Highway Research Board, National Research Council, Washington, D. C., December, 1927.

The data affecting them are those which were obtainable. Although these are not always complete it is the purpose to retell the facts, as obtained, through field observations, conferences, and published information.

The report is condensed to as brief a form as consistent with clarity and consists of:

1. Outline of the object, procedure and scope of the investigation.
2. Summary statement of conclusions.
3. Digest of conclusions.
4. Practical application of findings.
5. Presentation of findings.
6. Supplementary reports and discussions.

An outline was presented on November 1, 1927, to the Executive Committee of the Highway Research Board through the Director, Charles Upham.

The Executive Committee consists of the following members: T. R. Agg, chairman; W. H. Connell, A. J. Brosseau, H. C. Dickinson, A. N. Johnson, Thomas H. McDonald, William Spraragen.

Valuable assistance and cooperation were offered and given by the Bureau of Public Roads, Weather Bureau, Forest Service, Patent Office, practically all state highway departments and several counties.

Comment and suggestions were requested and received from representatives of the following industries: Asphalt, Tar, Portland Cement, Calcium Chloride, Lime, Rock Asphalt, Crushed Stone, Sand and Gravel, Machinery and Equipment.

The investigation was made financially possible by contributions from T. Coleman Dupont and the American Road Builders Association. The Asphalt Association and the American Tar Products Company are contributing to the cost of printing.

The National Research Council, through the Highway Research Board, has aided with clerical assistance.

The formal discussions today, as your program shows, will be made by authorities on the subjects with which their names appear. A logical sequence of these subjects was deemed advisable.

## Object, Scope and Procedure

### Object of the Survey

The object of this survey was to collect and correlate available information on the various types of low-cost improved roads.

Analyses of each type and comparisons between types have been made wherever the information could

be secured. In some instances this was not possible, since:

1. Maintenance costs and traffic counts were not available.
2. Few low-cost test roads have been built. Conclusions on these applied to local conditions.
3. Authentic records of salvage values have not been kept.
4. Detailed conditions surveys on satisfactory and unsatisfactory types would have required a considerable force of engineers over a period of several years.

The investigation is confined to roadways which are rendering a reasonable service under the field conditions which govern their construction and operation.

### Purpose of the Survey

The purpose of this report is to assist those interested in low-cost roads to improve and increase the mileage of this type by furnishing information on:

1. The use of local materials.
2. Methods of construction and maintenance.
3. Details which affect cost, traffic, capacity, selection of type and service.

### Procedure

Necessarily some data were obtained which were not sufficiently complete to be included, yet the procedure of obtaining whatever information was available was followed throughout and consisted of:

1. Study of typical cross sections, specifications, patents, official reports of state and county highway commissions, construction and maintenance of cost records, articles by highway engineers in the technical press and proceedings of various associations.
2. Conferences with highway engineers in both the technical and industrial field.
3. Field surveys of low-cost roads under service and construction conditions.
4. Inspection of machinery, equipment and materials.
5. Correlations of the results of this survey with those of previous and current investigations.

### Scope and Limits

The survey consisted of:

1. Study of typical cross sections from 26 states. Bureau of Public Roads and Forest Service.
2. Study of 30 sets of specifications.
3. Study of 64 sets of patents.
4. Study of 20 annual or biennial reports of state and county highway commissions.
5. Study of construction and maintenance cost data from 39 different states.

6. Study of leading technical articles and proceedings published during the past 7 years.
7. Conferences with highway engineers of 25 state departments and 7 industrial organizations.
8. Field inspections in 23 states of construction, maintenance and equipment.

The survey was limited in general to untreated surfaces which cost less than \$10,000.00 per mile, and to surface treatments and surface courses which cost less than \$6,000 per mile.

It was advisable to investigate other types whose cost exceeded these amounts. This was done on some which had been successful under particular local conditions, on others to show their relative position in cost and service compared with lower cost types.

### Presentation of Data

The data consist of:

1. Description of low-cost types selected because of service, economy and adaptability.
2. Photographs and typical cross section of the foregoing.
3. Extracts from specifications, patents, and laws which are pertinent to this investigation.
4. Materials of construction.
5. Construction and maintenance methods with photographs.
6. Equipment with photographs.
7. Climatic and soil conditions.
8. Traffic and service.
9. Construction and maintenance costs.
10. Table and charts supplementing the foregoing.
11. Digests of records, data and articles by builders of low-cost roads.
12. Reports and supplementary studies of this subject.

The types included are:

#### Untreated Surfaces

1. Sand Clay.
2. Disintegrated Granite and Shale.
3. Gravel in general.
4. Top dressing or traffic bound surfaces of Gravel, Slag and Stone.
5. Macadam.
6. Lime Rock, Caliche and Marl.
7. Miscellaneous surfaces of volcanic cinders, mine tailings and industrial wastes.

#### Surface Treatments and Surface Courses

8. Bituminous and non-bituminous dust layers.
9. Skin surface treatments.

10. Surface treatment with prime and seal coats.
11. Mixed-in-place bituminous surface—fine aggregate type.
12. Mixed-in-place bituminous surface—coarse aggregate type.
13. Pre-mixed, laid cold, bituminous surface course.
14. Natural Rock Asphalt.
15. Modified or puddle bituminous macadam. Cold application.
16. Bituminous macadam. Hot application.
17. Hot mix surface courses.
18. Miscellaneous base or surface of local materials and non-bituminous admixtures.

Each type is treated separately under the following sub-titles:

1. General description.
2. Materials.
3. Construction methods.
4. Maintenance methods.
5. Construction costs.
6. Maintenance costs.
7. Service.

Following the description of the various types are discussion and data under these headings:

1. Materials of construction and maintenance.
2. Methods of construction.
3. Methods of maintenance.
4. Costs of construction and maintenance.
5. Selection of type.
6. Selection of typical cross section.
7. Effect of climate and soil on types.
8. Service, traffic and costs.
9. Construction and maintenance equipment.

A practical application of the findings is made by showing a series of typical cross sections starting with the raw subgrade, stepping up to, and including, a high-type pavement.

A brief table of materials, costs and traffic capacity is shown with each progressive cross section.

The findings of the investigation are briefly summarized under three headings.

1. Conclusions.
2. Strong indications.
3. Further suggested research.

The total report including discussions will contain about 60,000 words, photographs, cuts of cross sections and tabulated data.

Today the report is condensed into a brief digest of the principal factors which affect this very broad subject.



They are Materials, Methods and Equipment for Construction and Maintenance, Cost of Construction and Maintenance, Selection of Type and Cross Section, Service and a Practical Application of the Results of the Survey.

## Materials

For clarity and brevity two general classifications of surfaces are made—untreated surfaces and treated surfaces.

### Materials For Untreated Surfaces

The predominating surfacing materials are gravel, sand clay, hard and soft stone, slag and lime rock. There are also miscellaneous materials such as shell, volcanic cinders and stone screenings.

Sand clays are used principally in the Southern States. According to Dr. Strahan, suitable sand clays should contain, clay from 12 to 18 per cent, silt 5 to 15 per cent, total sand 65 to 80 per cent, and sand above No. 60 sieve 45 to 60 per cent.

Gravels of various quality and gradation are used in nearly every state. Nearly all specifications require that gravel shall be hard and durable; that it shall all pass the  $1\frac{1}{2}$ " screen, or better still, through the 1" screen; California requires all gravel to be crushed. Clay in gravel as a binder is used sparingly.

Lime rock, marl, caliche and similar materials make excellent bases, but poor wearing surfaces. Because they are soft and crush during construction, large sizes up to  $3\frac{1}{2}$ " are permitted.

Crushed stone and crushed slag of a durable character are being used for surfacing in much the same manner as gravel construction in sizes through the  $1\frac{1}{2}$ " and 1" screen, and smaller. Stone for water-bound macadam or broken stone base is specified in larger sizes.

### Materials For Surface Treatment and Surface Courses

The principal binders or admixtures are asphalts, tars, calcium chloride, lime and Portland cement.

The principal aggregates are gravel, sand, stone or slag, and sand clay.

In the asphalt field the slower curing asphaltic oils are becoming less popular. Cut back asphaltic materials appear to be gaining in popularity.

Hot asphalt or hot tar as a second application in dual treatment work satisfies several state highway departments.

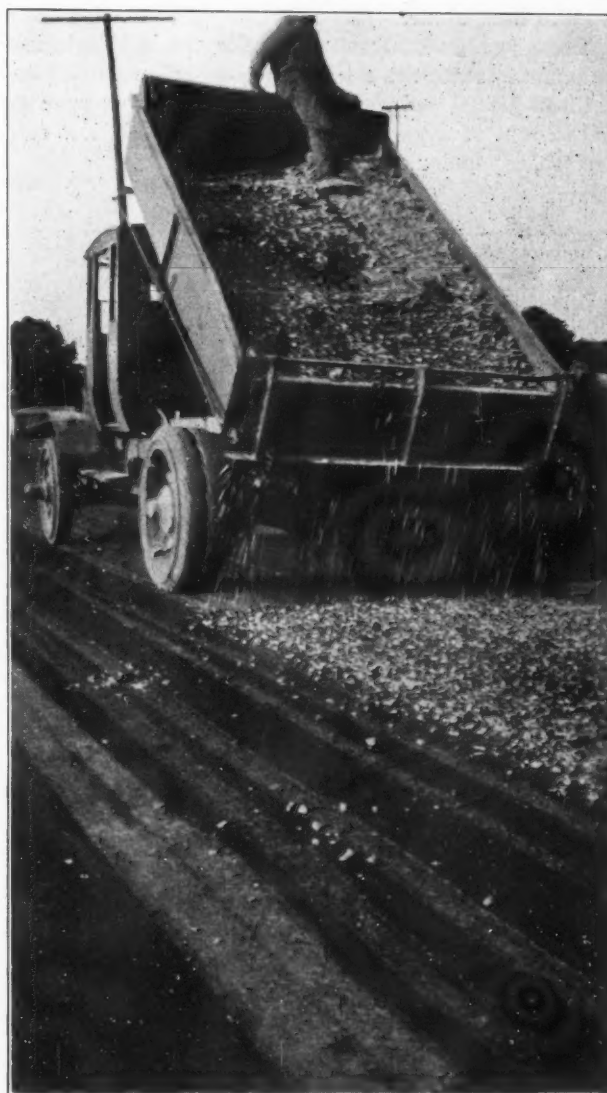
Premixed asphaltic surfaces are generally hot mixtures. Cut backs are being tried for mixed-in-place, premixed surfacing and cold penetration macadam.

Cold tars for surface treatment and mixed-in-place types of surfacing are giving good service in several states.

A new type of premixed surfacing is a cold patch tar mixed with stone in a concrete mixer.

Bitumens are the most widely used binder in the low-cost surfacing field.

Calcium chloride to lay dust and prevent loss of binder is used extensively near its source of supply. Sulphite liquors are not now used to any appreciable extent.



Stone being spread on prime coat preparatory to second application of tar.

Natural rock asphalt, when near its source, has entered the field of low-cost surfacing.

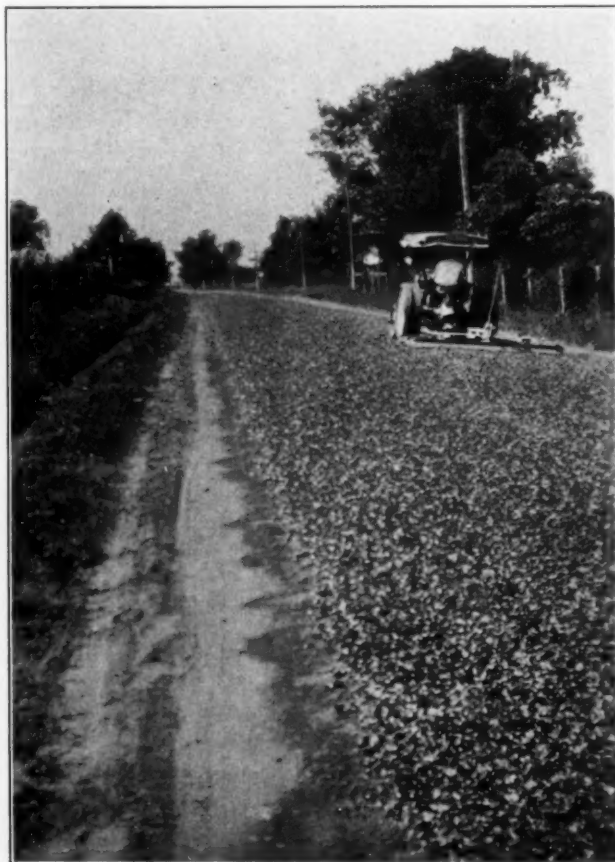
Portland cement with local sand or local fine gravel as an aggregate is a departure from former standards. The possibilities appear good for obtaining a serviceable pavement with these aggregates, provided expansion and contraction are properly controlled.

Hard crushed stone or dense hard slag are preferred to sand and gravel in dual treatment work of the penetration type.

Softer and more friable crushed stone when used for this purpose is specified in larger than customary sizes of hard stone.

There is a general preference for crushed materials in surface treatment work.

Clean gravel and clean coarse sand for this purpose on account of availability and comparatively low cost are still a popular cover material.



Dragging and Levelling after second application of tar.

Aggregates for mixed-in-place surfaces are generally those in the roadway surfacing itself. Examples are the work in Wisconsin, California, Indiana and the test road in South Carolina.

Work of a similar character as done in Tennessee and Pennsylvania require new materials as aggregate for the bituminous surface.

In this type of construction cold asphalt or tar are used as binder. The aggregate may be stone, slag, gravel or sand clay.

Premixed surfaces are usually hot mixes of the standard type such as bituminous concrete. When used with local sand or gravel the costs have been reduced. Examples are the sand asphalt work in North Carolina and the bituminous concrete on Cape Cod, Massachusetts.

Convenience in construction and possible economies in plant equipment and operation point with some favor to a premixed cold bituminous surfacing.

Cold penetration macadam is being built in the United States with cut-back asphalt or tar and in Europe with emulsions.

## Construction Methods

Construction methods may be discussed for three general types of surfaces:

- I. Untreated surfaces.
- II. Types using non-bituminous admixtures.
- III. Bituminous surface treatments and surface courses.

### I. Untreated Surfaces.

They are constructed by one of three principal methods:

1. Traffic Bound, Layer Method.
2. Traffic Bound, One Course Method.
3. Roller Bound, One or Two Course Method.

There are some variations in practice such as obtaining compaction by rolling in addition to that of traffic in both 1 and 2.

**1. Traffic Bound, Layer Method.** The principal example of this on an extensive scale is the recent work in Ohio. It has been practiced also in other states.

The object is to first stabilize the raw, compacted subgrade by the addition of clean hard aggregates.

Blading and dragging keep the surface regular. Traffic does the compacting. New aggregate is added periodically. This becomes bonded and keyed to that previously placed until a dense and regular surface is obtained. Compaction is thus secured from the bottom or subgrade in successive bonded layers.

The construction operations are simple and consist of hauling, dumping and spreading the aggregates. All of them are done by mechanical equipment. The same equipment is also used for maintenance.

**2. Traffic Bound, One Course Method.** This method is generally followed for the construction of selected soil, sand clay and one course gravel.

After the materials are dumped on the subgrade, the principal operations are mixing in place. This is accomplished by plowing, harrowing and blading. If rains are infrequent, sprinkling with water produces an increased density.

Traffic and hauling of surfacing material finally bring the surface down to a well compacted mass. It may be advisable to use a roller on materials which carry little or no binder. A heavy roller is successfully used on the lime rock bases of Florida, which bind together readily.

Some surfaces built by this method are not smooth because the aggregates were dumped in piles and allowed to stand before being spread and harrowed.

**3. Roller Bound, One or Two Course Method.** Water bound macadams using various aggregates come under this heading.

The method is primarily to spread a layer of coarse aggregate, shape it, roll lightly and then fill the voids with a finer aggregate. Water may or may not be sprinkled on the surface to assist in the void filling and binding process. Compaction is secured by frequent and protracted rolling.

These surfaces are seldom as smooth as those which use blading or dragging as a part of the construction process.

## II. Types Using Non-Bituminous, Cold Admixtures.

The non-bituminous methods may be classed as:

1. The surface application method.
2. The mixed-in-place method.
3. The premixed method.

**1. The Surface Application Method.** Calcium chloride is applied to the surface in flake or powder from a lime spreader. The spreader is hauled by a truck. Frequent, light applications of  $\frac{1}{2}$  pound per square yard appear to be favored over less frequent and heavier applications.

If a light surface mulch of fine gravel is retained on the roadway surface the chloride appears to be more effective.

**2. The Mixed-in-Place Method.** The principal work of this method has been experimental. Lime or Portland cement is mixed with road soils. The soil is first

loosened by plowing and harrowing. The admixture is then applied, followed by mixing with plow, harrow or road blader. The final surface contour is obtained by blading. Traffic does the compacting.

**3. Premixed Method Cold.** Although limited in actual work done, this method is included because of future possibilities of utilizing local materials.

Portland cement is the binder.

The binder and aggregate are mixed in a concrete mixer, dumped and spread in much the same manner as standard Portland cement concrete paving. The aggregates are quite fine (all passing the  $\frac{3}{8}$ -inch screen) which allows unusual freedom in methods of finishing. A patented cement known as Soilamies cement has never been perfected.

## III. Bituminous Treatments and Surface Courses.

New construction methods with bituminous binders have been developed during the past four years. These methods are principally the results of usage with some field experimentation.

As in nearly all classes of road construction there are three principal methods of construction:

1. The Penetration Method.
2. The Mixed-in-Place Method.
3. The Premixed Method.

Bituminous treatments as dust layers will not be covered in this summary.

**1. The Penetration Method.** This method is in common usage for penetration macadam. Quite recently a binder course of penetrated stone between base and top has been developed. The penetration method is used in all types of surface treatment work; that is, surface treatments which include one or more applications of bitumen and one or more spreadings of cover material.

For the dual treatment or two-application method the principal operations are:

1. Cleaning the base.
2. Application of prime coat.
3. Omission or spreading of light cover. (Omission is better.)
4. Second application of bitumen.
5. Immediate cover.

Note: The order of 4 and 5 may be reversed.

6. Spreading of cover with brooms or drags.
7. Compaction with a roller or by traffic.

Tightly bound surfaces of stone, gravel, sand clay, lime rock and various other surfaces are suitable for this method. The smoothness of the resulting surface



is almost directly dependent on the smoothness of the surface to be treated.

**2. The Mixed-in-Place Method.** From present indications the main features of the mixed-in-place method are growing in popularity. It is comparatively new. It was developed in Wisconsin about 1923 as a means for forming a bituminous surface on gravel roads which had a loosely bound surface. Today its principal features are used on sand clay roads, crushed and screened gravel roads and on old or new macadams.

A surface of appreciable thickness from  $\frac{3}{4}$  to 3 inches compacted thickness may be constructed. The resulting surface is regular in contour and has smooth riding qualities. Minor irregularities in the old surface are automatically corrected by this constructive process.

There are two principal types of the mixed-in-place method; one in which no new aggregates are added to the existing surface, the other in which the base is undisturbed and new aggregates are added for mixing with the bitumen.

#### Using Aggregates Already in Roadway Surface

1. Bring surface to be treated to a regular and smooth contour.
2. Scarify if necessary to the proposed depth of new surfacing, harrow, blade and shape.
3. Apply first coat of bitumen and mix with harrow and road blade.
4. Apply second coat and mix thoroughly.
5. Sometimes a third coat is applied followed by more mixing. Mixing is continued until a uniform color results.
6. Follow with a final shaping by road blade or drag.
7. Secure initial compaction by rolling. Traffic may serve the purpose.
8. A seal coat of bitumen and chips, gravel or sand may be necessary.

Practise in some states calls for a blading of material to the road side. The exposed surface is then treated with a prime coat. This is followed by a second application. The material at the roadside is then bladed over the treated surface and mixed by blading back and forth across the road.

#### Using New Aggregates

1. The old compact surface is smoothed and patched.
2. A prime coat of bitumen is applied and allowed to penetrate. It may be left under traffic for several days. A light cover of aggregate may be applied to prevent picking up by traffic.

3. If cover is applied it is bladed or turned over with a road machine set nearly cross-wise of the road.
4. The second coat of bitumen is applied and covered with aggregate.
5. Blading is continued until the cold mix begins to set up.
6. Compaction is preferably secured by a roller instead of traffic alone.

Final cover material may be applied before the second application of bitumen. There is no conclusive data to show which is the preferable sequence.

A third method may be used in which bitumen is mixed with the materials in the road and compacted in place; followed by the addition of new aggregates which are treated and mixed with bitumen—making in effect two courses.

**3. Premixed Method.** Premixed methods using hot mixtures are so well known that details will not be covered today. The hot mixed macadam as used in Canada differs but little from black base, two-course construction.

The cold mixes are somewhat new, they offer few construction difficulties and interruptions to traffic.

When used on other than concrete bases a prime coat is growing in favor; as is also a thin bituminous binder course of stone penetrated or mixed with bitumen.

### Maintenance Methods

There are three principal methods of keeping a road surface serviceable.

1. Addition of new materials which are similar to those in the existing surface.
2. Blading and dragging.
3. Patching.

All three methods including scarifying may be necessary on any one type of road.

The addition of new materials is common practice, and a necessity on gravel and sand clay roads. This is done at varying intervals of from one to four years.

Light blading or dragging from two to six times a week, regardless of weather, is the practice in states which have good gravel surfaces.

The heavy road machine and heavy road drag or planer are now being used on water bound, and bituminous macadams, and cold premixed types. Good results in securing a smoother surface are reported. The bituminous macadams are treated with a prime of bitumen the day previous to the planing.



Rollers for practically all types of bituminous surface treatments and surface courses are generally recommended for initial compaction.

The power distributor has practically replaced hand pouring methods for applying bitumens.

Large mileages of low type surfaces appear to be dependent on mobile equipment for economical construction and maintenance.

For experimental purposes and competition in bidding for work there appear to be some advantages in having several types of roadway surfaces, but a high quality of maintenance appears to be more easily sustained when the number of types is small.

## Costs of Construction and Maintenance

Considering the costs and types of construction in the state highway systems only, the following table is made, for an assumed width of 18 feet.

### Types Costing Less than \$10,000 Per Mile

Type	Miles
Sand Clay and Top Soil.....	11,395
Gravel, Chert, Shale, etc.....	79,286
(Treated and Untreated)	
Total .....	90,681

### Types Costing More Than \$10,000 Per Mile (including base)

Type	Miles
Water Bound Macadam (Treated and Untreated)	18,428
Bituminous Macadam by Penetration.....	12,927
Sheet Asphalt and Bituminous Concrete.....	5,706
Portland Cement Concrete.....	31,936
Block Pavements .....	3,380
Total .....	72,377

Surfaces costing more than \$10,000 per mile are about 45% of the total, and less than \$10,000 are 55%.

If we classify on a \$20,000 basis then water bound macadam with and without surface treatments come below this figure. We then have 33% costing more than \$20,000 per mile, and 67% costing less.

## Selection of Type

Selection of type is greatly affected by the availability of local materials. Thus we find sand-clays in several of the Southern States, gravel in nearly every state in the union, stone in those states which can produce it economically and lime rock in Florida.

Our state highway systems have the largest percentage of high type surfaces, but this amounts to only 33% of their total. Counties and townships have even a smaller percentage.

In their state highway systems Georgia, North Carolina, South Carolina, Vermont and Virginia, each have over 1000 miles of sand clay; Arkansas, Colorado, Louisiana, Michigan, Minnesota, Mississippi, Ohio, Texas and Wisconsin each have over 3000 miles of treated and untreated gravel; Indiana, Kentucky, Maryland, New York, Ohio, Pennsylvania, Tennessee, and Virginia each have over 1000 miles of treated and untreated water bound macadam.

A study of Federal-aid road mileage shows sand clay as 9.3 per cent, gravel 38 per cent, water bound macadam 2 per cent.



Rolling after dragging.

For Federal-aid roads the statement is made by the Bureau that sand clay is decreasing in popularity, gravel shows little change and water bound macadam a decrease.

The higher type surfaces show an increase in popularity on Federal-aid work with Portland cement concrete showing the greatest gain.

In 1924 the total surfaced mileage in the country was 467,905.

Sand Clay .....	13.6%
Gravel .....	52.2%
Water Bound Macadam .....	12.9%
Surface Treated Macadam and Gravel .....	5.7%
All other Types .....	15.6%
	<hr/> 100.00

Among the several untreated types of surfacing the traffic bound stone, slag or gravel surface as built in Ohio is an excellent example of good low-cost road service.

Calcium Chloride in Michigan has served as a satisfactory dust layer on gravels.

The dual surface treatment work on lime rock in Florida is excellent.

The mixed-in-place methods for resurfacing old macadams as practised in Pennsylvania and Tennessee are smooth and serviceable.

The mixed-in-place methods on gravel or stone surfaces as practised in Wisconsin, California, Indiana and Minnesota give promise of a satisfactory method of greatly improving many miles with this type.

The dual surface treatments as practised in Maine on gravels and North and South Carolina on sand clays show reasonable results.

The experimental work in South Carolina for improving the serviceability of poor quality sand clays is a step in the right direction.

Selection of type is a prescription proposition.

An engineer who is already familiar with the local conditions of his own surfaces, available materials and funds, will do well to make an examination of the work done by others under similar conditions. His final choice will be more easily and intelligently made.

### Selection of Cross Section

From a study of typical cross sections there appear three principal types for untreated surfaces; the feather edge, from out-to-out shoulder; the trench section of uniform thickness; and a combination of the trench section for the middle two-thirds which is topped with a feather edge section extended to the outer edges of the shoulders.

Surface treatments and surface courses are usually of uniform thickness. They extend in most instances over the entire width of old surface.

Edge strengthening is being considered as evidenced by sections which show a wider base than top, a thickened edge similar to the Bates section, the use of headers of bituminous concrete, Portland cement concrete or timber.

A section stepping up by using a decreasing width of surface for the various courses is shown by one state.

There is a marked tendency toward flatter crowns. Few exceed  $\frac{1}{2}$  inch to the foot, many show in plan and in the field  $\frac{3}{8}$  inch to the foot and some recommend and use as low as  $\frac{1}{4}$  inch. The growing popularity of the flat crown is apparent in untreated surfaces, surface treatments and higher type pavements.

### Service

Road service is frequently reckoned on the cost of maintenance per vehicle-mile or per ton-mile. There is no good reason for not including the cost of construction.

A few states are trying to make their selection of type on the cost of maintenance basis. Reports indicate that they have not made definite conclusions as a result of their observations.

Based on statements and claims made by highway engineers in responsible authority the following data is presented.

Sand clay surfaces cost from \$1,000.00 to \$2,400.00 per mile, they will carry from 150 to 550 vehicles per day, including light trucks, at an annual maintenance cost of \$300.00 to \$600.00 per mile.

Gravel surfaces cost from \$4,000.00 to \$10,000.00 per mile and will carry from 250 to 550 vehicles per day including light trucks, at an annual maintenance cost of \$300.00 to \$600.00 per mile.

Untreated water-bound macadam surfaces cost more than gravel.

Traffic-bound stone, slag and gravel surfaces cost about \$2,000.00 per mile the first year, \$1,000.00 the second, and \$500.00 the third. They will carry 300 to 600 vehicles per day, including light trucks.

Dual bituminous treatments on good substantial bases cost \$1,000.00 to \$3,500.00 per mile for the first year, and will carry from 700 to 1000 vehicles per day, including light trucks, at an annual maintenance cost of \$400.00 to \$1,000.00 per mile.

Mixed-in-place bituminous surfaces, depending on their thickness, are costing from \$1,000.00 to \$4,500.00

per mile, and are reported to be carrying about the same traffic as dual treatments at about the same maintenance cost.

They are smoother riding than dual treatments, and they should be more durable.

Premixed surfaces and penetration macadam cost from \$8,000.00 to \$15,000.00 per mile and will carry from 1500 to 2500 vehicles per day at an annual maintenance cost of from \$200.00 to \$500.00 per mile.

In some instances they are carrying heavier and denser traffic.

Tire wear has been shown to be heavier on untreated surfaces.

Traffic-bound and mixed-in-place surfaces are smoother riding than surfaces which are rolled only.

Character and quality of service are affected by climatic, soil and organization conditions.

Gravel roads require more frequent scarifying in states which have severe frost conditions.

Dust is a much more serious problem in Arizona than in Alaska.

Several states reduce the number of vehicles and their weights during the period when frost is leaving the ground. A reduced maintenance cost results.

To demonstrate a practical application of this survey in which improved road service may be had at a reasonable cost, four tentative tables are presented. The costs and traffic conditions are assumed for no particular piece of road. They are based on costs and traffic counts for average known conditions. They are made to cover a six-year period. Six years are taken because some engineers have assumed them to be the economic life of so-called transitory types.

TABLE I

Type.—One-course Gravel Treated With Calcium Chloride

Note: Costs and Traffic Assumed.

	Daily	
	Costs	Traffic
1. First year—Construction and Maintenance..	\$5,000.00	300
2. Second year—Construction and Maintenance..	300.00	400
3. Third year—New Material, Calcium Chloride and Maintenance of Surface.....	1,000.00	500
4. Fourth year—New Materials, Calcium Chloride and Maintenance of Surface.....	700.00	600
5. Fifth year—New Materials, Calcium Chloride and Maintenance of Surface.....	700.00	700
6. Sixth year—New Materials, Calcium Chloride and Maintenance of Surface.....	700.00	700
	<hr/>	<hr/>
	\$8,400.00	3200
Cost of Construction and Maintenance.....	8,400.00	
Interest at 4%.....	1,588.00	
	<hr/>	<hr/>
Total.....	\$9,988.00	

Average cost per year  $\$9,988.00 \div 6 = \$1,665.00$ .

Average daily traffic  $3200 \div 6 = 533$ .

Road service in cost per vehicle mile =  $\$1,656.00 \div (533 \times 365) = \$.008$ .

Estimated working time for constructing one mile of surface, without traffic, 10 days.

TABLE II

Type. Traffic Bound Stone, Slag or Gravel With Bituminous Surface

Note: Costs and Traffic Assumed.

	Daily	
	Cost	Traffic
1. First year—Construction and Maintenance..	\$2,000.00	300
2. Second year—New Material and Maintenance	1,000.00	400
3. Third year—New Material and Maintenance	1,000.00	500
4. Fourth year—Mixed-in-Place Surface.....	3,000.00	1000
5. Fifth year—Maintenance .....	1,000.00	1000
6. Sixth year—Maintenance.....	500.00	1000
	<hr/>	<hr/>
Cost of Construction and Maintenance.....	\$8,500.00	4200
	<hr/>	<hr/>
Cost of Construction and Maintenance....	\$8,500.00	
Interest at 4%.....	1,300.00	
	<hr/>	<hr/>
Total .....	\$9,800.00	
Average cost per year = $\$9,800 \div 6 =$	1,633.00	
Average daily traffic = $4200 \div 6 =$	700.	
Road service in cost per vehicle mile = $\$1,633.00 \div (700 \times 365) =$	\$.006.	

Estimated working time for constructing one mile of surfacing first year's work, with traffic passing through, 3 days.

TABLE III

Type. Existing Macadam Improved with Bituminous Surface

Note: Costs and Traffic Assumed.

	Daily	
	Cost	Traffic
1. First year—Shaping, new material of loose fine surface mulch.....	\$2,000.00	500
2. Second year—Maintenance .....	1,000.00	600
3. Third year—Mixed-in-place Surface.....	3,000.00	1000
4. Fourth year—Maintenance .....	1,000.00	1000
5. Fifth year—Maintenance .....	500.00	1000
6. Sixth year—Maintenance.....	500.00	1000
	<hr/>	<hr/>
Cost of Construction and Maintenance.....	\$8,000.00	5100
	<hr/>	<hr/>
Cost of Construction and Maintenance....	\$8,000.00	
Interest at 4%.....	1,340.00	
	<hr/>	<hr/>
Total .....	\$9,340.00	
Average cost per year $\$9,340.00 \div 6 =$	1,557.00	
Average daily traffic $5100 \div 6 =$	850	
Road service in cost per vehicle mile $\$1,557.00 \div (850 \times 365) =$	\$.005.	
Estimated working time for constructing bituminous surface with traffic passing through, 5 days.		

(Continued on page 19)



## Explosives Engineer Offers Trophy For N. C. S. A. Safety Competition

IN HIS personal letter of congratulation to the winners of the National Safety Competition for the year 1925, Herbert Hoover wrote "The American working man leads the world in individual productivity, but our expenditure of human life through industrial accidents has robbed us of much of the net advantage of our efficiency in production. Since there are more than 200,000 accidents in the mining and quarrying industries annually, it is easy to foresee great economic benefits from this great nation-wide movement, in which during its first year more companies and individuals participated than in any other organized safety contest."

So great has the interest in this competition for the bronze Sentinels of Safety trophies grown that to determine the winners in each of the five groups for 1926, required the tabulation and analysis by the United States Bureau of Mines of all accidents occurring during 95,000,000 man hours of labor.

In the quarry industry, according to W. W. Adams, of the Bu-

reau of Mines, under whose supervision the National Safety Competition from the beginning has been con-

ducted, "Safety is a matter of direct concern to more than 92,000 men who are employed in the industry, and it is also of almost equally direct concern to their immediate families. Thus between 300,000 and 400,000 people are personally affected by the accidents that occur in connection with the annual production of crushed stone in the United States. From 120 to 150 men are killed by accidents in quarries each year, and 14,000 of them are injured non-fatally."

From these statistics each crushed stone producer can visualize the economic as well as the humanitarian importance of cooperating in organized effort to reduce loss of life, time and money from accidents in his industry and at his plants.

Every year since the National Safety Competition was inaugurated an increasing number of members of the National Crushed Stone Association have entered their plants and have been benefitting from the increased interest





in safety among their men. These operators have also derived real value from the statistical analyses issued by the Bureau of Mines which enable them to know, confidentially, how their safety record compares with others entered in the competition without, of course, revealing any other companies by name.

Thus far, however, no member of the National Crushed Stone Association has succeeded in winning the Sentinels of Safety trophy awarded in the quarry group. In 1926, fourteen participating quarries went through the year without a lost-time accident, two of which were operated by members of the National Crushed Stone Association. To determine the winners among the fourteen plants with perfect records, the Jury of Awards was obliged to give consideration to both the aggregate man hours worked and to the average number of hours worked by each man, and on this basis the Martinsburg, W. Va., quarry of the North American Cement Corporation was awarded the trophy.

Feeling that the remarkable record made by the National Crushed Stone Association members whose plants had gone through the year without an accident, and in order to provide an even greater incentive for all members of the Association to enter the contest, The Explosives Engineer magazine has offered an additional trophy to be awarded each year to the quarry operated by a member of the National Crushed Stone Association having the best record in the National Safety Competition, as determined by the United States Bureau of Mines. This trophy, of which an illustration is shown, consists of a 10" x 20" bronze plaque mounted in an ebony frame. The quarry scene, in bas-relief, is a reproduction of the quarry panel on the pedestal of the Sentinels of Safety Trophy. Below will be engraved each year the name of the quarry adjudged by the United States Bureau of Mines as having the best record among those quarries entered in the competition that are operated by members of the National Crushed Stone Association. Each time a member company wins the trophy at any of its plants, it will be credited with a leg on the trophy; three legs will entitle a company to retain permanent possession of the trophy, and a replica will be supplied to the National Crushed Stone Association by the Explosives Engineer, as the award for succeeding winners.

#### First Winner of the N. C. S. A. Trophy

Mr. W. W. Adams, of the United States Bureau of Mines, was requested by Mr. J. R. Boyd to decide which quarry should receive the award, also which

were in second and third place, and therefore entitled to honorable mention. Mr. Adams replied as follows:

"We have placed the plant of the Louisville Cement Company, situated at Speed, Clark County, Indiana, in first position because it had an exposure of 2,934 hours per man without an accident as against an exposure of 2,810 hours per man without an accident for the Monroe Limestone Quarry of the France Stone Company. In addition to this the aggregate exposure of the Louisville plant was 227,750 hours as against 70,170 hours for the Monroe plant.

"In the contest rules for 1927 and 1928 we have incorporated a rule that all plants having no lost-time accidents shall be ranked according to the number of hours or exposure per man during the contest year. This seems to us to be the most satisfactory way to place the small plants and the large plants on an equal basis of competition.

"I think the plan of your association to give recognition to the winner among your membership is a most laudable one and I hope that it will arouse the enthusiastic interest of all your members."

Mr. Adams enclosed with his letter the following analysis of the statistics from which the winner and the two companies receiving honorable mention were determined:

Louisville cement rock quarry, Speed, Clark County, Indiana, operated by the Louisville Cement Company. Operated 326 days in 1926 and worked 227,750 man-hours. Employs 78 men. Had no accidents during the contest year. Each employee worked about 2,934 hours during the year. This quarry has a record of 865 days without a lost-time accident. Average hours worked per man, 2,934.

#### First Honorable Mention

Monroe limestone quarry, Monroe, Monroe County, Michigan, operated by the France Stone Company. Operated 281 days in 1926 and worked 70,170 man-hours. Employs 25 men. Each employee worked about 2,810 hours during the year. Had no accidents.

#### Second Honorable Mention

Wickwire limestone quarry, Gasport, Niagara County, New York. Operated by the Wickwire Spencer Steel Company. Operated 221 days and worked 91,042 man-hours. Employs 41 men. Had 1 accident causing 2 days lost time, making a frequency rate of 10,984 and a severity rate of .022.

## The Crushed Stone Journal

J. R. BOYD, Editor

A. T. GOLDBECK, Director, Bureau of Engineering

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## Manufacturers' Division Exposition Will Be Largest Yet Held

The Manufacturers' Division Exposition of Quarry Equipment and Machinery to be held in conjunction with the Eleventh Annual Convention of the Association at West Baden, Indiana, January 16 to 19, 1928, will, without doubt, be larger and more comprehensive than any of its predecessors. Practically every variety of quarry equipment and machinery will be on display at this show. All of the exhibitors will have men in attendance at the convention who are conversant with the details of their respective equipment and who will be glad to give information to anyone desiring it.

The United States Bureau of Mines, the United States Bureau of Public Roads and the National Safety Council will have special exhibits which should prove of unusual interest and value. Taking it all in all it's going to be a great show and every crushed stone producer of the United States and Canada should by all means be there and bring his superintendents and operating men.

An inspection of this exposition is a course in quarry operation which you cannot afford to miss. There is given below a list of those who have to date indicated their intention of having exhibits at the Exposition. There remain but five booths which have not been taken and therefore we earnestly suggest that anyone desiring space who has not yet applied, immediately wire the Washington Office.

### Manufacturers Who Will Exhibit at West Baden

Allis-Chalmers Manufacturing Co., Milwaukee, Wisconsin.

American Manganese Steel Co., Chicago Heights, Illinois.

American Tar Products Co., Pittsburgh, Pennsylvania.

Armstrong Manufacturing Co., Waterloo, Iowa.

Atlas Powder Co., Wilmington, Delaware.

Bakstad Crusher and Equipment Corp., Chicago, Illinois.

Blaw-Knox Co., Pittsburgh, Pennsylvania.

Bucyrus Co., South Milwaukee, Wisconsin.

Burrell Engineering and Construction Co., Chicago, Illinois.

Cement, Mill and Quarry, Chicago, Illinois.

Cross Engineering Co., Carbondale, Pennsylvania.

Davis and Averill, Newark, New Jersey (pending approval of application for membership).

E. I. duPont de Nemours and Co., Wilmington, Delaware.

The Dorr Company, New York City.

Easton Car and Construction Co., Easton Pennsylvania.

Fate-Root-Heath Co., Plymouth, Ohio.

Flexible Steel Lacing Co., Chicago, Illinois.

General Electric Co., Schenectady, New York.

Good Roads Machinery Co., Kennett Square, Pennsylvania.

Grasselli Powder Co., Cleveland, Ohio.

Harnischfeger Sales Corp., Milwaukee, Wisconsin.

Hayward Company, New York City.

Heisler Locomotive Works, Erie, Pennsylvania.

Hendrick Manufacturing Co., Carbondale, Pennsylvania.

Hercules Powder Co., Wilmington, Delaware.

Ingersoll-Rand Company, New York City.

Jeffrey Manufacturing Co., Columbus, Ohio.

Kennedy-Van Saun Manufacturing Co., Cleveland, Ohio.

Keystone Lubricating Co., Philadelphia, Pennsylvania.

Koppel Industrial Car and Equipment Co., Koppel, Pennsylvania.

Loomis Machine Co., Tiffin, Ohio.

Manganese Steel Forge Co., Philadelphia, Pennsylvania.

Marion Steam Shovel Co., Marion, Ohio.

McGraw-Hill Catalog and Directory Co., New York City.

National Crushed Stone Association, Washington, D. C.

National Malleable and Steel Castings Co., Cleveland, Ohio.

National Safety Council, Chicago, Illinois.

Niagara Concrete Mixer Co., Buffalo, New York.

Orville Simpson Co., Cincinnati, Ohio.

The Osgood Company, Marion, Ohio.

Pit and Quarry, Chicago, Illinois.

Rinek Cordage Company, Easton, Pennsylvania.

Robins Conveying Belt Co., New York City.

Rock Products, Chicago, Illinois.

Sauerman Brothers, Inc., Chicago, Illinois.

Smith Engineering Works, Milwaukee, Wisconsin.

Stearns Conveyor Co., Cleveland, Ohio.

Symons Brothers Co., Chicago, Illinois.

Taylor-Wharton Iron and Steel Co., High Bridge, New Jersey.

The Thew Shovel Company, Lorain, Ohio.

Traylor Engineering and Manufacturing Co., Allentown, Pennsylvania.

Traylor Vibrator Co., Denver, Colorado.

Troco Lubricating Co., Philadelphia, Pennsylvania.

The W. S. Tyler Co., Cleveland, Ohio.

Union Explosives Co., Clarksburg, West Virginia.

United States Bureau of Mines, Washington, D. C.

United States Bureau of Public Roads, Washington, D. C.

Vulcan Iron Works, Wilkes-Barre, Pennsylvania.

Williams Patent Crusher and Pulverizer Co., St. Louis, Missouri.

### Summary of Report on Investigation of Low Cost Improved Roads

(Continued from page 15)

TABLE IV

Type. Portland Cement and Local Aggregates

Note: Costs and Traffic Assumed.

	Costs	Daily Traffic
1. First year—Construction and Maintenance	\$22,200.00	1000
2. Second year—Maintenance	200.00	2000
3. Third year—Maintenance	200.00	3000
4. Fourth year—Maintenance	200.00	3000
5. Fifth year—Maintenance	200.00	3000
6. Sixth year—Maintenance	200.00	3000
	\$23,200.00	15000

Cost of Construction and Maintenance..... \$23,200.00

Interest at 4%..... 5,328.00

Total..... \$28,528.00

Average cost per year  $\$28,528.00 \div 6 = \$4,755.00$

Average daily traffic  $15,000 \div 6 = 2500$

Road service in cost per vehicle mile  $\$4,755.00 \div (2500 \times 365) = \$0.005$ .

Estimated working and curing time for constructing one mile of pavement, without traffic, 20 days.

The tables indicate that low cost improved surfaces will give road service at about the same cost per vehicle mile for construction, maintenance and interest on investment as for higher cost surfaces. The funds invested are less for the lower type. The four types will still be serviceable at the end of a six-year period for their respective traffic capacities, but interest must still be paid on more than \$28,000.00 for the cement concrete pavement and on less than \$10,000.00 for the bituminous and surface treated roadways.

Low cost road surfaces in the past have failed principally from overloading and the lack of intelligent maintenance.

With proper regulation of these two important factors low cost improved roads can be built and continued in service.

### The 1928 Safety Competition

(Continued from page 5)

If the Association were called upon to provide the necessary personnel to properly conduct this work, a considerable financial outlay would be involved, whereas by entering the Safety Competition and thereby placing upon the Bureau of Mines the responsibility of collecting and analyzing this data, very valuable information is obtained without any cost whatsoever to the Association. Also, the arousing of the competitive spirit among employees very decidedly helps to increase interest in accident prevention.

In order that tangible recognition might be given each year to the member of the Association entered in the competition establishing the best record, The Explosives Engineer has very generously offered the N. C. S. A. Safety Trophy, a detailed description of which appears elsewhere in this issue. Recognition will also be given to the companies receiving first and second honorable mention in the form of a reproduction of the trophy printed on parchment and framed.

For the convenience of our members, there is enclosed with this issue of the Journal an entry blank for the 1928 National Safety Competition which gives all details relative to eligibility and the rules of the contest. We earnestly request that all of our eligible members immediately fill out this blank and forward it to the Bureau of Mines. The 27% representation for 1927 should be increased to 100% for 1928. We are confidently counting on your support to help make 1928 a banner safety year.



## Active Members of the National Crushed Stone Association

Acme Limestone Co., Alderson, W. Va.  
 Adams & Duford Co., Chaumont, N. Y.  
 Albany Crushed Stone Co., 55 State St., Albany, N. Y.  
 American Crushed Rock Co., Ostrander, Ohio.  
 American Limestone Co., Box 262, Knoxville, Tenn.  
 American Lime and Stone Co., Bellefonte, Pa.  
 American Stone Ballast Co., High Bridge, Ky.  
 Anna Stone Company, Anna, Ill.  
 Ashland Limestone Co., 408 Ashland National Bank Bldg., Ashland, Ky.

Basalt Rock Co., Inc., Napa, Calif.  
 Beachville White Lime Co., Beachville, Ont., Canada.  
 C. C. Beam, Melvin, Ohio.  
 Belmont-Gurnee Stone Co., North Bergen, N. J.  
 Bessemer Limestone & Cement Co., 714 Stambaugh Bldg., Youngstown, Ohio.  
 Blackwater Stone Co., 1016 Baltimore Ave., Kansas City, Mo.  
 Blake Brothers Co., 204 Balboa Bldg., San Francisco, Calif.  
 Blue Diamond Co., 1650 South Alameda, Los Angeles, Calif.  
 Blue Ridge Stone Co., Roanoke, Va.  
 Boggs, Burnam & Co., Richmond, Ky.  
 Bound Brook Crushed Stone Co., Bound Brook, N. J.  
 Consolidated Crushed Stone Corp., 1016 Baltimore Ave., Kansas City, Mo.  
 Britton Crushed Stone Corp., 717 Commerce Bldg., Rochester, N. Y.  
 Brownell Improvement Co., 1220 Chamber of Commerce Bldg., Chicago, Ill.  
 Buffalo Cement Co., 110 Franklin St., Buffalo, N. Y.  
 Buffalo Crushed Stone Co., 1048 Ellicott Square, Buffalo, N. Y.

Callanan Road Improvement Co., P. O. Box 773, Albany, N. Y.  
 Harry T. Campbell Sons Co., Inc., Towson, Md.  
 Canada Crushed Stone Corporation, Hamilton, Ont., Canada.  
 Carbon Limestone Co., 1005 1st Nat'l Bank Bldg., Youngstown, Ohio.  
 The Carolina Stone Co., Charleston, S. C.  
 Carthage Crushed Limestone Co., P. O. Box 409, Carthage, Mo.  
 The Casper Stolle Quarry & Contracting Co., 503 First National Bank Bldg., East St. Louis, Ill.  
 Cedar Bluff Quarry, Princeton, Ky.  
 Cerulean Stone Co., Cerulean, Ky.  
 Chico Stone Products Co., 404 Santa Fe Bldg., Dallas, Texas.  
 City Motor Trucking Co., Ft. of E. Salmon St., Portland, Ore.  
 The Collins Granite Co., Inc., R. F. D. No. 4, Danville, Va.  
 Columbia Quarry Co., 1612 Syndicate Trust Bldg., St. Louis, Mo.  
 Commonwealth Quarry Co., Summit, N. J.  
 The F. E. Conley Stone Co., 253 Union Station, Utica, N. Y.  
 Connecticut Quarries Co., New Haven, Conn.  
 Consolidated Stone & Sand Co., Clare Road, Montclair Heights, Essex County, N. J.  
 Consumers Company, 111 W. Washington St., Chicago, Ill.  
 Cooper Crushed Stone Co., Inc., Plymouth, Pa.  
 A. Courchesne, Inc., El Paso, Texas.  
 Cushing Stone Co., Inc., 437 State St., Schenectady, N. Y.

Daniel Contracting Co., 503 Market St., San Francisco, Calif.  
 Davis Bros. Stone Co., Lannon, Wis.  
 Delaware River Quarry & Construction Co., 21 Bridge St., Lambertville, N. J.  
 Dittling & Lime Co., New Braunfels, Tex.  
 Dolese Bros. Co., 337 West Madison St., Chicago, Ill.  
 Dolese & Shepard, 111 W. Washington St., Chicago, Ill.  
 Dolomite Products Co., 124 E. & B. Bldg., Rochester, N. Y.  
 Doolittle Limited, Hamilton, Ontario, Canada.  
 Duluth Crushed Stone Co., 1506 Alworth Bldg., Duluth, Minn.  
 John T. Dyer Quarry Co., Norristown, Pa.  
 Dubuque Stone Products Co., Dubuque, Iowa.

Elmhurst-Chicago Stone Co., Elmhurst, Ill.  
 Erie Stone Co., Ft. Wayne, Indiana.  
 Eyeremann Construction Co., 1210 S. Grand Blvd., St. Louis, Mo.  
 Fay Quarries, 101 Union St., New Bedford, Mass.  
 Federal Stone Co., 133 West Washington St., Chicago, Ill.  
 France Stone Co., 1800 2nd National Bank Bldg., Toledo, Ohio.  
 The France Co., Toledo, Ohio.

The France Limestone Co., Greencastle, Indiana.  
 The France Quarries Co., Urbana, Ohio.  
 Franklin Limestone Co., 612 10th Ave. N., Nashville, Tenn.

General Crushed Stone Co., Drake Bldg., Easton, Pa.  
 Genessee Stone Products Co., Batavia, N. Y.  
 Gordon Crushed Stone Co., 18 Toronto St., Toronto, Canada.  
 Graham Bros., Inc., 1512 W. 7th St., Long Beach, Calif.  
 Granite Rock Co., Box M, Watsonville, Calif.  
 Great Notch Corporation, 20 Washington Place, Newark, N. J.  
 Greenfield Broken Stone Co., Box 49, Greenfield, Mass.  
 Greer Limestone Co., Morgantown, W. Va.  
 Grove City Limestone Co., Sharon, Pa.

Hagersville Contracting Co., Ltd., Hagersville, Ontario, Canada.  
 Hagersville Quarries, Ltd., 4 Flora St., St. Thomas, Ont., Canada.  
 Hall Bros. Crusher, Brownwood, Texas.  
 Hardaway Contracting Co., Woodleaf, N. C.  
 Harris Granite Quarries Co., Salisbury, N. C.  
 Hartford Sand & Stone Co., 15 Lewis St., Hartford, Conn.  
 Edward Hely Stone Co., Cape Girardeau, Mo.  
 Holston Quarry Co., Robbins Bldg., Box 292, Knoxville, Tenn.  
 T. C. Hubbert & Co., Inc., 707 S. Broome St., Wilmington, Del.  
 Hughes Stone Co., 808 Mayo Bldg., Tulsa, Okla.  
 Chas. O. Hunsicker, Hunsicker Bldg., Allentown, Pa.

Interstate Crushed Stone Co., P. O. Box 129, Springfield, N. J.  
 James Stone Co., Corsicana, Texas.

Kelley Island Lime & Transport Co., 1125 Leader-News Bldg., Cleveland, Ohio.  
 Kentucky River Stone & Sand Co., Lawrenceburg, Ky.  
 Kentucky Rock Asphalt Co., Marion E. Taylor Bldg., Louisville, Ky.  
 Keystone Trappe Rock Co., Glenmore, Pa.  
 John T. Kilcourse, 70 Belknap St., Lawrence, Mass.  
 Kirkfield Crushed Stone, Ltd., 136 Confederation Life Bldg., Toronto, Canada.  
 Kittanning Limestone Co., Safe Deposit Bldg., Kittanning, Pa.

Lake Erie Limestone Co., 901 Wick Bldg., Youngstown, Ohio.  
 Lake Shore Sand and Stone Co., 600 Canal St., Milwaukee, Wis.  
 Lambertville Stone Quarry Co., Colonial Trust Bldg., Philadelphia, Pa.  
 Landa Rock Products Co., New Braunfels, Texas.  
 John S. Lane & Son, Inc., Meriden, Conn.  
 Lawrence Stone & Gravel Co., 516 Commercial Bank Bldg., Raleigh, N. C.  
 Lehigh Stone Co., Kankakee, Ill.  
 LeRoy Lime & Crushed Stone Corp., LeRoy, N. Y.  
 Liberty Lime & Stone Co., Rocky Point, Va.  
 Ligonier Stone Products Co., Blairsville, Pa.  
 Linwood Cement Co., 714 Kahl Bldg., Davenport, Iowa.  
 L. & M. Stone Co., Mayo Bldg., Utica, N. Y.  
 Louisville Cement Co., 315 Guthrie St., Louisville, Ky.  
 Lutz Stone Company, Oshkosh, Wis.  
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Manegold Stone Co., Alois, Wisconsin.  
 Marble Cliff Quarries Co., 907 Hartman Bldg., Columbus, Ohio.  
 Mayville White Lime Works, Mayville, Wis.  
 Joseph McCormick, 319 Taunton Ave., East Providence, R. I.  
 Mid-West Crushed Stone Co., 514 Traction Terminal Bldg., Indianapolis, Ind.  
 Mississippi Lime and Material Co., 201 W. 3rd St., Alton, Ill.  
 Mohawk Limestone Co., Mohawk, N. Y.  
 Monon Crushed Stone Co., Box 366, Monon, Ind.  
 Montreal Crushed Stone Co., 590 Union Ave., Montreal, Canada.  
 Morris County Crushed Stone Co., 17 South St., Morristown, N. J.  
 Mussels Ltd., Phillips Place Bldg., Montreal, Canada.

National Lime & Stone Co., Findlay, Ohio.  
 National Stone Company, Box 832, Joliet, Ill.  
 New Braunfels Limestone Co., New Braunfels, Texas.  
 New Castle Lime & Stone Co., 500 Greer Bldg., New Castle, Pa.



New Haven Trap Rock Co., 67 Church St., New Haven, Conn.  
 Newton County Stone Co., Kentland, Indiana.  
 North Shore Material Co., 133 W. Washington St., Chicago, Ill.  
 Northwestern Quarry Co., Rapid City, S. D.  
 The Ohio Marble Co., Piqua, Ohio.  
 Ohio & Indiana Stone Co., Greencastle, Indiana.  
 Old Colony Crushed Stone Co., Quincy, Mass.  
 A. C. O'Laughlin Co., 131 N. Homan Ave., Chicago, Ill.  
 Orange Quarry Co., Eagle Rock Ave., West Orange, N. J.

Palmetto Quarries Co., Columbia, S. C.  
 Peerless Quarries, Inc., 404 Court St., Utica, N. Y.  
 Pembroke Limestone Corporation, Pembroke, Va.  
 Penn Limestone & Cement Co., 40 N. Duke St., Lancaster, Pa.  
 Piedmont Corporation, Bona Allen Bldg., Atlanta, Ga.  
 Pounding Mill Quarry, Pounding Mill, Va.

Quartzite Quarries, Inc., Luverne, Minn.  
 Queenston Quarries, Ltd., St. Davids, Ontario, Canada.

Raleigh Granite Co., Raleigh, N. C.  
 Reinhold & Co., Inc., 1422 Oliver Bldg., Pittsburgh, Pa.  
 River Products Co., Iowa City, Iowa.  
 Rock-Cut Stone Co., 537 Union Bldg., Syracuse, N. Y.  
 Rock Hill Quarry & Const. Co., 1026 Title Guaranty Bldg., St. Louis, Mo.  
 Tayloe Rogers, Radford Limestone Corp., 1st Nat'l Bank Bldg., Roanoke, Va.  
 Rowe Contracting Co., Malden, Mass.

St. Marys Crushed Stone, Ltd., 136 Confederation Life Bldg., Toronto, Canada.  
 Saluda Crushed Stone Co., 214 Capers Bldg., Greenville, S. C.  
 J. D. Sargent, Mt. Airy, N. C.  
 Schumacher Stone Co., Pandora, Ohio.  
 Leatham D. Smith Stone Co., Sturgeon Bay, Wis.  
 Solvay Process Co., 40 Rector St., New York City.  
 Southern Mineral Co., 523 Gravier St., New Orleans, La.  
 Southern Crushed Stone & Granite Co., R. F. D., Trenton, S. C.  
 Sowerbutt Quarries, Paterson, N. J.  
 Spartanburg Quarries Corp., 139½ E. Main St., Spartanburg, S. C.  
 Spreckels Commercial Co., 310 Fourth St., San Diego, Calif.  
 Stringtown Crushed Rock Co., McAlester, Okla.

Thomas Sullivan, 526 Sunderland Bldg., Omaha, Nebr.  
 Sunlight Crushed Stone Co., Madisonville, Ky.  
 The Supply Distributors Corp., Marion Bldg., Cleveland, Ohio.  
 Susquehanna Stone Co., 725 Greenwood Ave., Williamsport, Pa.

The Tarbox-McCall Stone Co., 852 Weston Ave., Findlay, Ohio.  
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 Trap Rock Company, Minneapolis, Minn.  
 Jas. C. Travilla, Pilot Knob Ore Co., 211 N. 7th St., St. Louis, Mo.  
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Union Quarry & Constr. Co., 806 Security Bldg., St. Louis, Mo.  
 Union Rock Co., 7th & Los Angeles Sts., Los Angeles, Calif.  
 Universal Granite Quarries Co., 133 W. Washington St., Chicago, Ill.  
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Van Camp Stone Co., 12 E. 6th St., Cincinnati, Ohio.  
 Virginian Limestone Corp., 505 Mt. Trust Bldg., Roanoke, Va.

Wagner Quarries Co., Schmidt Bldg., Sandusky, Ohio.  
 Waterstreet Trap Rock Co., Water Street, Pa.  
 Watertown Stone Products Co., 839 Washington St., Watertown, N. Y.  
 Waukesha Lime & Stone Co., Waukesha, Wis.  
 Welden Springs Quarry Co., Inc., Welden Springs, Mo.  
 Wentworth Quarries, Ltd., Vinemount, P. O., Ontario, Canada.  
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 West Penn Cement Co., 2215 Oliver Bldg., Pittsburgh, Pa.  
 Whitehouse Stone Co., Spitzer Bldg., Toledo, Ohio.  
 Whiterock Quarries, Bellefonte, Pa.  
 Wickwire Spencer Steel Corp., Station B, Buffalo, N. Y.  
 Winston & Co., Inc., Masonic Bldg., Harrisburg, Pa.  
 Wisconsin Granite Co., 105 W. Monroe St., Chicago, Ill.  
 Wood County Stone & Const. Co., Bowling Green, Ohio.  
 Woodville Lime Products Co., 622 Madison Ave., Toledo, Ohio.

York Hill Trap Rock Quarry Co., 98 State St., Meriden, Conn.  
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*Design and Construction.*

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*"Explosives of All Kinds and Blasting Accessories."*

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*Belting: Transmission, Conveyor, Elevator; Hose, Packing.*

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*Coal and Coke.*

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The Hendrick Mfg. Co., Carbondale, Pa.  
*Perforated Metal Screens, Elevator Buckets.*

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*Geared Locomotives.*

Hercules Powder Co., Wilmington, Del.  
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*Mitchell Electric Vibrating Screen.*

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*Rock Drills, Steel Sharpeners, Oil Furnaces and Hoists.*

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Koppell Industrial Car and Equipment Co., Koppel, Pa.  
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*Blast Hole, Prospecting and Drilling Machinery and Tools.*

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*Power Shovels and Cranes—Steam, Gasoline and Electric.*

Mid-West Locomotive Works, Cor. Spring Rd. and Alabama Ave., Cincinnati, Ohio.

*Quarry Locomotives.*

National Malleable & Steel Castings Co., 10600 Quincy Ave., Cleveland, Ohio.

*Naco Cast Steel Steam Shovel Chain and Certified Malleable Castings.*

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*Screens, ROTEX, level, self-cleaning, 100 to 3/4" mesh.*

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Peerless Explosives Co., 22 N. Franklin St., Wilkes-Barre, Pa.  
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Pit and Quarry, Rand McNally Bldg., Chicago, Ill.  
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Robins Conveying Belt Co., 15 Park Row, New York City.  
*Material Handling and Screening Equipment.*

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*Drills, Big Blast Hole, Drilling and Fishing Tools.*

Sauerman Bros., Inc., 438 S. Clinton St., Chicago, Ill.  
*Cableway Excavators, Power Scrapers.*

Smith Engineering Works, 32nd and Locust Sts., Milwaukee, Wis.  
*Rock Crushers—Gyratory, jaw and reduction.*

The Stearns Conveyor Co., 200th St. & St. Clair Ave., Cleveland, Ohio.  
*Material Handling Machinery.*

Symons Bros. Co., 111 W. Washington St., Chicago, Ill.  
*Ore, Rock and Gravel Crushers.*

S. G. Taylor Chain Co., 140 So. Dearborn St., Chicago, Ill.  
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Taylor-Wharton Iron & Steel Co., High Bridge, N. J.  
*TISCO Manganese Steel Castings.*

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The Traylor Engineering & Mfg. Co., Allentown, Pa.  
*Crushing, Cement and Mining Machinery.*

Traylor Vibrator Co., 1400 Delgany St., Denver, Colorado.  
*Vibrating "Screen Supreme."*

Trojan Powder Co., Allentown, Pa.  
*Explosives and Blasting Supplies.*

Troco Lubricating Co., Philadelphia, Pa.  
*Manufacturers of Petroleum Products.*

The W. S. Tyler Co., Cleveland, Ohio.  
*Woven Wire Screens and Screening Equipment*

Union Explosives Co., Clarksburg, W. Va.  
*Explosives and Blasting Supplies.*

Vulcan Iron Works, Wilkes-Barre, Pa.  
*Steam, Gasoline, Electric Locomotives.*

Western Wheeled Scraper Co., Aurora, Ill.  
*Western Portable Rock Crushers.*

George D. Whitcomb Co., Rochelle, Ill.  
*Gasoline Locomotives.*

Williams Patent Crusher and Pulverizer Co., 813 Montgomery St., St. Louis, Mo.  
*Hammer Crushers.*







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# Eleventh Annual Convention

West Baden, Indiana

January 16, 17, 18 and 19, 1928

## Remember

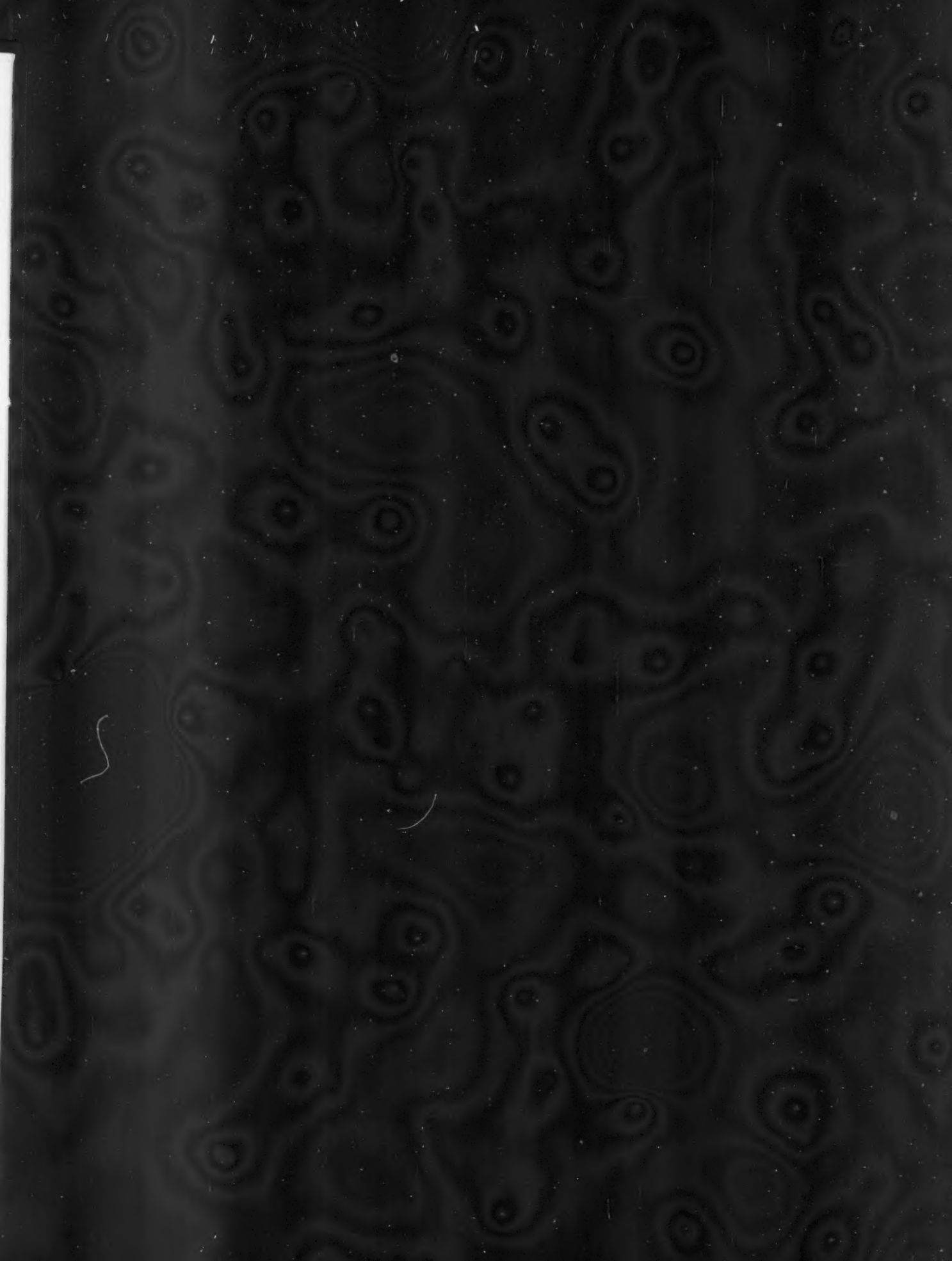
1. That room reservations should be made immediately by writing direct to The West Baden Springs Hotel.
2. That, if you have not received your round trip identification certificate, a request for one should be promptly sent to the Secretary's Office in Washington. No certificates will be distributed by ticket agents as has been the custom in past years.
3. That every crushed stone producer in the United States and Canada should be present at this annual foregathering of the industry. Be sure to be there and bring your salesmen, superintendents and operating men with you.

# National Crushed Stone Association

651 Earle Building

Washington D. C.



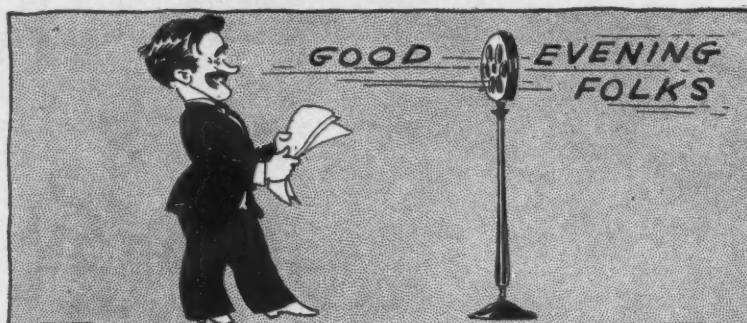




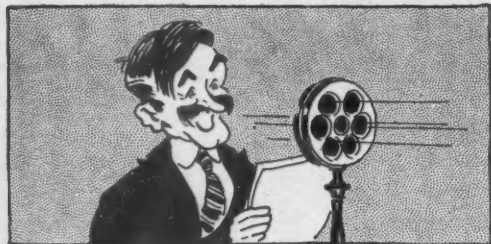
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By A. B. Chapin

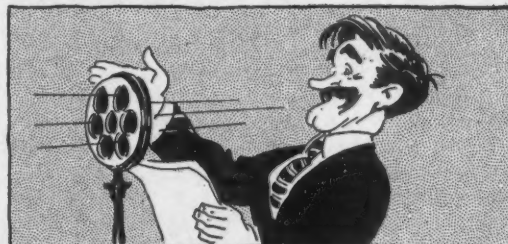
(Courtesy Explosives Engineer)



**T**HIS IS BLASTER BILL SPEAKING THROUGH STATION **N.C.S.A.**  
I HOPE EVERY QUARRYMAN IN THE U.S.A. IS LISTENING IN —  
FOR I AM ABOUT TO BROADCAST AN IMPORTANT MESSAGE FROM  
PRES. GRAVES OF THE NATIONAL CRUSHED STONE ASSOCIATION.



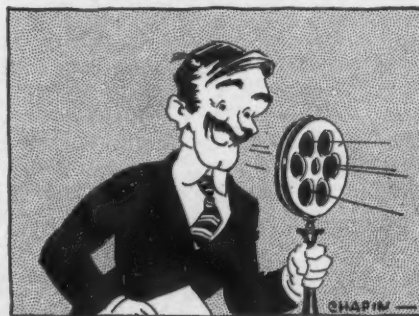
**H**E SAYS THAT **EVERY** QUARRYMAN IN  
THE COUNTRY SHOULD CERTAINLY JOIN  
THE ASSOCIATION — AND YOU CAN  
BET THAT I MOST HEARTILY AGREE WITH  
HIM, BECAUSE IT IS AN ORGANIZATION  
WHICH IS CONSTANTLY WORKING IN ALL  
PROPER AND ETHICAL WAYS FOR THE  
ADVANCEMENT OF THE INDUSTRY —



**A**LSO, ITS BUREAU OF ENGINEERING  
REPRESENTS THE INDUSTRY ON TECHNICAL  
COMMITTEES FORMULATING STANDARDS AND  
SPECIFICATIONS — IT COOPERATES WITH  
STATE HIGHWAY DEPARTMENTS — IT  
SOLVES PARTICULAR TECHNICAL PROBLEMS  
AND DISSEMINATES INFORMATION THROUGH  
THE CRUSHED STONE JOURNAL AND  
ENGINEERING BULLETINS —



**F**RIENDS, IT'S ONLY BY MEANS OF A STRONG  
NATIONAL GROUP THAT THE NEEDS OF THE  
CRUSHED STONE INDUSTRY CAN BE PROPERLY  
PRESENTED TO AUTHORITIES, AND WHAT BENEFITS  
THE INDUSTRY GENERALL SPEAKING —  
BENEFITS YOU AS INDIVIDUALS.  
IN THIS EACH OF YOU IS NEEDED TO  
INCREASE THE STRENGTH OF THE ASSOCIATION—



**F**URTHERMORE — DON'T FORGET THE VALUE  
OF **N.C.S.A.** CONVENTIONS  
'T'S A GREAT ADVANTAGE TO EVERY ONE  
WHO BELONGS — IF YOU DON'T BELONG,  
**JOIN NOW** AND ATTEND THE NEXT ONE.  
MR. J.R. BOYD, 651 EARLE BUILDING,  
WASHINGTON, D.C., AWAITS YOUR REQUEST  
FOR AN APPLICATION FORM — I THANK YOU!

